SIMULATION OF LARGE SPACE TRUSS STRUCTURES WITH SEMI-ACTIVE FRICTION JOINTS

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The low structural damping of large space structures and the stringent positioning requirements in missions demand effective vibration suppression. The present approach is based on friction damping in semi-active joints, each releasing a single degree of freedom thus enabling relative sliding between the connected parts. The energy dissipation due to interfacial slip in the friction joints can be controlled by varying the normal pressure in the contact area using a piezo-stack actuator. This paper focuses on identification and model reduction of a large space structure with semi-active joints.

For the purpose of model identification and model reduction, the nonlinear friction forces transmitted in the joints are considered as external forces acting on the linear truss structure. Experimental Modal Analysis results are used to update the FE model of the truss structure and the parameters of the nonlinear friction model are identified from measured responses of an isolated joint. The model of the linear subsystem is reduced by a combination of balanced reduction and matching moments method. Based on the open-loop state space model of the linear truss structure, modal reduction is performed using controllability and observability gramians. To improve the fidelity of the reduced model for lower frequencies, the approximation error due to the neglected modes is compensated by augmenting the modal subspace with Krylov vectors.

At optimal locations conventional rigid connections are replaced by adaptive joints, each with a local feedback controller for the adaptation of the normal force. To improve the damping performance the control parameters are optimized with respect to the transient response of the adaptive structure. Simulation results of a 10-bay truss structure with semi-active joints show the potential of the present approach.